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THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

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IN THIS ISSUE

David H. Marsden presents evidence for the value of sustained programs in local control of Dutch elm disease, page 3.

Puratized Agricultural Spray and Bordeaux mixture gave best control of scab on Pyracantha in three years of tests in Delaware, according to R. S. Cox, page 7.

Results of 1952 tests with fungicide mixtures for the control of apple scab and rust in the Hudson Valley of New York are reported by D. H. Palmiter and F. H. Emerson, page 11.

John C. Dunegan and others describe a rapid method for mass inoculation of pear trees with the blight bacterium, page 14; the method should give a more precise test of susceptibility of large numbers of trees than was hitherto possible.

H. W. Anderson believes that "black tip" is less suitable than the not wholly satisfactory "spring canker" as a descriptive name for the combined symptoms of the overwintering phase of Xanthomonas pruni on peach, at least as observed in Illinois, page 16.

P. W. Miller sends his annual summary of incidence of nut diseases in Oregon, page 18.

Two papers on strawberry virus studies are contributed by P. W. Miller; the first, page 19, concerns transmission of the yellows virus complex by single strawberry aphids, the second, page 20, reports results of tests for virus infection in wild strawberries.

According to results of experiments reported by V. E. Wilson and H. C. Murphy, page 21, red leaf disease of oats as observed in Iowa is a systemic virus disease.

H. H. McKinney discusses occurrence of soil-borne wheat mosaic viruses in the Great Plains, page 24.

Soil-borne mosaic viruses of wheat were found in Oklahoma during the 1952 season for the first time, according to D. F. Wadsworth and H. C. Young, Jr., page 27.

W. H. Sill, Jr., and H. Fellows describe the effect of temperature on symptoms of the wheat streak-mosaic virus disease, page 30.

Occurrence of a chlorotic streak disease of Pennisetum purpureum in Puerto Rico is reported by G. W. Bruehl, page 34; the disease resembles the chlorotic streak virus disease of sugarcane but relationships have not been determined.

P. A. Young describes symptoms of hormone injury in tomato, pepper, and Rudbeckia, page 36.

A species of Pratylenchus has been found associated with root deterioration of sugarcane in the Louisiana field affected with Sclerospora disease, according to Wray Birchfield, page 38.

Harold J. Jensen reports some observations on occurrence and control of the root-lesion nematode disease of narcissus in the Pacific Northwest, page 39.

Don C. Norton and F. A. Frank, page 41, discuss conditions favoring attack by Sclerotium bataticola on guayule in southwest Texas.

In brief notes, page 44, O. H. Elmer and others report that oak wilt is now known to occur in seven northeastern Kansas counties.

November weather, page 45.

889208

Vol. 37, No. 1--PLANT DISEASE REPORTER--Jan. 15, 1953

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DUTCH ELM DISEASE: AN EVALUATION OF PRACTICAL CONTROL EFFORTS[1]

David H. Marsden

The Dutch elm disease (Ceratostomella ulmi) will never be eradicated; we must learn to live with the disease. This statement is a premise on which plant pathologists and arborists will agree. However, in the light of this cold, rational conclusion about the inevitability of the disease, many cities and towns are forced to decide what "learning to live with Dutch elm disease" shall mean to them. Should they abandon their elms to the ravages of the disease, or should they undertake a long-term program to preserve as many elms as possible? Both courses of action are so expensive that they deserve careful consideration.

"How much good does it do to attempt to control Dutch elm disease?" Few reports have yet been published giving reliable statistics in answer to this pertinent question. In 1946, Zentmeyer et al.[2] analyzed data from the extensive federal scouting and roguing programs carried on in four Connecticut townships from 1934 to 1940 and later extrapolated further data from small, random plots in the same towns. Their analyses indicated that the progress of Dutch elm disease in these towns had been arithmetic with time. Further interpretation of the data indicated that seven years of eradicating afflicted trees had almost no effect on later increase of disease in those towns. However, the same statistics quoted by these authors can be analyzed to obtain quite a different picture of the disease situation in the four towns during and after the scouting and eradication program. For example, the town of Greenwich had an annual average of 0.107 percent of elms affected during the seven-year period of active control efforts by the federal agency and 0.54 percent during the subsequent four-year period. Stamford went from an annual average of 0.116 percent to 4.20 percent; Darien, from 0.166 percent to 2.72 percent; and Norwalk, from 0.084 percent to 1.59 percent. It would seem, then, that the minimum in loss of elms was due to the seven-year control program. It may be true that once control efforts cease, the disease can build up rapidly to a point where it probably would have been if control had not been attempted at all, but that is not a valid argument against a sanitation program. On the contrary, it is proof that sanitation suppresses the disease and saves elms. It is interesting to note in these statistics that the town with lowest total disease incidence is Greenwich -- a town notable for its outstanding work in fighting Dutch elm disease.

Although a recent report by Liming et al.[3], on the effect of Dutch elm disease on the elm population of a limited area during a three-year period, demonstrates clearly the immediate hazard of allowing diseased, beetle-infested elms to stand near healthy elms, it also indicates that disease incidence declines with time, despite a lack of control. This observation does not coincide with what has been observed and reported elsewhere. Perhaps these anomalies may be resolved by further studies over wider areas and for longer periods of time.

The Shade Tree Laboratories of the University of Massachusetts have been in a favorable position to observe the effects of Dutch elm disease on the elm populations of towns within the State, and to evaluate the worth of practical control programs. Some facts regarding the destructiveness of Dutch elm disease, under different circumstances, in two comparable towns of Massachusetts, are presented here as being of possible interest and value to plant pathologists and others who may be obliged to recommend policies with regard to the Dutch elm disease problem.

Case Histories

The two towns to be cited as examples are Amherst and Easthampton. Both are located in the Connecticut River Valley, in Massachusetts, about ten miles apart. Amherst has sustained a vigorous effort to protect its elms; Easthampton made an equally good effort for a few years and then neglected the problem for two years.

Amherst: Amherst is a college town with a resident population of about 8500; it includes an area of 27.5 square miles, and has 72 miles of town roads. A 1952 census listed 2094 roadside elms, which are the responsibility of the town to maintain.

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[1] Contribution No. 871 of the Massachusetts Agricultural Experiment Station.

[2] Zentmeyer, G. A., J. G. Horsfall, and P. P. Wallace 1946. Dutch elm disease and its chemotherapy. Connecticut Agric. Expt. Sta. Bul. 498: 70 pp.

[3] Liming, O. N., E. G. Rex, and K. Layton. 1951. Effects of a source of heavy infection on development of Dutch elm disease in a community. Phytopath. 41:146-151.

The Dutch elm disease was first discovered in Amherst in 1948. At that time, and up until June 30, 1950, the town was scouted thoroughly for Dutch elm disease at least once a year by personnel from the Shade Tree Laboratories. During the remainder of 1950 and 1951, nearly all the scouting was done by the town tree department. Amherst undertook a practical sanitation program early to control the disease, and has sustained this program up to the present time. All known diseased elms have been eradicated as promptly as time permitted, with priority given to those diseased trees located near concentrations of desirable elms. Diseased wild elms, in pastures and along streams, were disposed of in turn. In 1952, for the first time, the street elms were sprayed with DDT for protection against elm bark beetles; prior to that, spraying was done in certain areas for control of elm leaf beetles only. Table 1 indicates the progress of Dutch elm disease under these circumstances.

Easthampton: Easthampton is an industrial town with a population of about 10,700, an area of 14 square miles and 67 miles of town roads. According to a 1952 census, there were approximately 965 roadside elms, two inches or more in diameter, within the town.

The Dutch elm disease was first found in Easthampton in 1947. At that time, and up until June 30, 1950, trained scouts surveyed the town thoroughly, at least once a year, for disease-suspect elms. During this time the town tree department was active in eradicating such diseased trees as were located in the surveys. Apparently, during the remainder of 1950 and in 1951, little was done to locate new infections or to remove obviously diseased trees, with the exception of those that became a hazard to the public safety. In 1952, interest in preserving the elms has been renewed, but the two years of neglect have had a striking effect on the town's roadside elm population as indicated in Table 1.

The Present Situations

In the spring of 1952, a census was taken of the roadside elms in Amherst and in Easthampton. All elms, two inches or more in diameter, which are the responsibility of the local tree officers, were counted and classified according to size. No attempt was made to determine the number of privately owned elms, since in this instance the number of street elms in each town is a fair indication of the comparative, total elm populations. The original number of street elms could be calculated approximately by adding to the 1952 totals all the street elms known to have been confirmed for Dutch elm disease prior to 1952. This figure was used for calculating the percentage of roadside elms affected since the disease started in each town.

During the summer of 1952, each town was scouted thoroughly three times for Dutch elm disease by experienced personnel from the Shade Tree Laboratories. Samples were taken from suspect trees, and the presence or absence of the Dutch elm disease fungus confirmed by laboratory culture technique. No tree was recorded as having Dutch elm disease unless Ceratostomella ulmi was isolated from parts of that tree. Sampled trees were identified with numbered, metal tags.

Table 1 indicates the numbers of known affected elms in each town, year by year. The numbers of privately owned shade tree elms, and wild or "weed" elms, recorded as "other" elms in the Table, are included as being of interest even though percentage figures for these trees could not be calculated.

The Costs of Protection and Neglect

The story told by Table 1 is vivid. Of particular significance is the total percentage of roadside elms affected in each town for the entire period that the disease has been present. Easthampton has lost 12.4 percent of its street elms, whereas Amherst has lost only 4.9 percent. Expressed another way, Easthampton has lost 122 street elms of an original population of 981, whereas Amherst has lost 109 of an original 2183.

It may be argued that the disease has been present a year longer in Easthampton than in Amherst, and that it is not fair to compare the results of six years of disease with that of five years. However, it is undoubtedly true that had Easthampton been scouted as diligently as Amherst during 1950 and 1951, the total of confirmed, diseased elms for Easthampton would be appreciably higher than it is. The 1952 surveys would not account for diseased elms that had been removed during these two years without confirmation, nor for those remaining dead trees in which the fungus had died out by the summer of 1952. It should be noted that despite an imperfect record of the disease in Easthampton, the average annual incidence of Dutch elm disease for that town has been more than 2 percent, whereas for Amherst the figure is 1 percent.

A comparison of the money spent by the two towns for the care of their trees is relevant

Table 1. The progress of Dutch elm disease in two Massachusetts towns.

Year	Amherst			Easthampton		
	Number roadside elms diseased	Percent of roadside elms diseased	Number other elms diseased	Number roadside elms diseased	Percent of roadside elms diseased	Number other elms diseased
1947	(Disease not present)			3	0.3	10
1948	2	0.08	12	9	0.9	18
1949	23	1.0	39	4	0.4	37
1950	46	2.1	79	0	0.0	10
1951	18	0.85	42	(No records)		
1952	20	0.99	78	106	11.0	136
Total number diseased	109		250	122		211
Total percent diseased		4.9	?		12.4	?

Table 2. Amounts appropriated for Dutch elm disease and general tree care.

Year	Amounts appropriated ($)			
	Amherst		Easthampton	
	General	D.E.D.	General	D.E.D.
1947	*		2499	0
1948	3250	0	2541	749
1949	4000	400	2500	499
1950	3500	4500	1999	1647
1951	4000	4500	2470	1650
1952	4000	4500	3560	11750
Totals	18750	13900	15569	16295
Combined totals	32650		31864	

*No disease present therefore figure not included.

to the discussion. The sums appropriated for general tree care and for Dutch elm disease work, since the disease started in the respective communities, are listed in Table 2.

Amherst has allotted an average of $6530 per year for general tree care and Dutch elm disease control during the five years that the disease has been present. During the six years of Dutch elm disease in Easthampton, that town has allotted an average of $5311 per year for

the same purposes. This amounts to approximately $3 per year per street elm for Amherst, and about $5.40 per year per street elm for Easthampton. No matter how it is figured, the cost of two years of neglect has been high in both money expended and elms lost for Easthampton.

Sanitation and Spraying

Although we have no comparable statistics to prove the value of DDT spraying in Dutch elm disease control, there are good reasons to believe that judicious spraying is a valuable adjunct to sanitation. Some cities and towns purport to have reduced the Dutch elm disease to a status equal to other elm diseases, by a good program of sanitation and spraying. A single specific illustration of this, known to the writer, is the campus of the University of Massachusetts at Amherst. There are approximately 493 elms on the campus, under the care of the University. These trees are pruned regularly to remove deadwood, some are fed at intervals, and all are given dormant and foliar sprays with DDT to control elm bark beetles. In spite of the presence of the disease in the surrounding areas of the town for five years, with over 350 known affected trees, only one elm on the campus has been affected. This excellent record may be credited in part to the spray programs, but it is questionable if such a low degree of disease incidence could be maintained on the campus were the town of Amherst not so diligent in its own elm sanitation program.

Conclusions

In general, the example of Amherst versus Easthampton is a case for an intelligent, sustained program to control Dutch elm disease. Specifically, the figures quoted are a measure of how much disease control can be effected by a practical sanitation program alone. In this instance, the sustained scouting and sanitation work in Amherst has so far resulted in a reduction of more than 50 percent in the number of diseased trees as compared to Easthampton. The emphasis should be on a sustained program, since the figures show that the disease can spread tremendously, in as short a time as two years, when control efforts slacken. Further evidence of the value of a combined sanitation and spray program, and of a spray program alone, are urgently needed.

SHADE TREE LABORATORIES, UNIVERSITY OF MASSACHUSETTS, AMHERST

CONTROL OF PYRACANTHA SCAB[1, 2]

R. S. Cox

Scab (Fusicladium pirinum var. pyracanthae (Orth.) Rostrup) is a common disease on Laland firethorn (Pyracantha coccinea lalandi Dipp.) in Delaware. Infection occurs on the fruit, leaves, and young twigs. Fruit abscission, often as high as 100 percent, reduces the ornamental value of this shrub. Infected attached leaves, twigs, and fruit provide a reservoir of inoculum where the fungus persists from year to year in the vegetative stage (1). Inoculum thus tends to build up, resulting in increasingly severe defoliation.

Standard recommendations for control of scab are Bordeaux mixture and lime sulfur (2, 5). These materials are frequently objectionable because of unsightly residue, phytotoxicity, and/or inadequate control.

During the past three years, 1950-1952 inclusive, several of the newer fungicides, together with the standard fungicides, were field-tested to determine their effectiveness in scab control. Limited studies were also made on the effect of timing of applications on disease control. Results are summarized in this report.

EXPERIMENTAL PROCEDURE

A commercial planting of severely infected firethorn shrubs located near Lincoln, Delaware, was selected for this work. Test plots consisted of one replicate for each treatment in 1950 and 1951 and two replicates for each treatment in 1952. In all cases, each replicate consisted of several closely-grouped plants. Because of uniform natural infection of all test plants, the limited number of replications employed is not considered a serious limitation in interpretation of results.

A small power sprayer delivering 350 pounds pressure was used, and the spray applied with a two-nozzle broom. Accurate data on spray gallonage were not obtained owing to nonuniformity of size of the shrubs. Good uniform coverage, however, was attempted.

1950 Test: The program in 1950 was primarily that of screening several fungicides for their relative effectiveness in scab control. A total of 10 applications was made, the first on April 20 and the rest at approximately ten-day intervals thereafter. Results are shown in Table 1.

Bordeaux mixture and Puratized Agricultural Spray exhibited greatest effectiveness. Fermate, although giving good control, was somewhat less effective, particularly from the standpoint of fruit infection. The remaining materials (liquid lime sulfur, Phygon XL, and Magnetic 70 sulfur) reduced leaf infection considerably, but did not materially reduce fruit infection as compared with that in the untreated plots.

Plant injury was caused by Bordeaux mixture and, to a lesser extent, by Puratized Agricultural Spray (1). The former material caused moderate to severe foliage and fruit injury which resulted in considerable defoliation and shriveled unsightly fruit. Puratized Agricultural Spray caused no apparent foliage injury, but appeared to prevent normal fruit coloration. This injury, though objectionable, was not considered of such serious magnitude as to prohibit its use. The remaining materials were not noticeably phytotoxic. In fact, the fruit from shrubs treated with Fermate actually appeared to be slightly above average size and exceptionally deep in color.

1951 Test: The purpose of the work in 1951 was twofold: (a) to compare the effectiveness of certain additional fungicides with the more promising ones tested in 1950, and (b) to study the effect of timing and the number of applications of Bordeaux mixture and Fermate on control. Materials tested, frequency of applications and control data are shown in Table 2.

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[1]Published as Miscellaneous Paper No. 157, with the approval of the Director of the Delaware Agricultural Experiment Station. Contribution No. 51 of the Department of Plant Pathology.

[2]The following materials were supplied by the manufacturers: Puratized Agricultural Spray (phenyl mercuri triethanol ammonium lactate), Gallowhur Chemical Corp.; Fermate (ferbam) (ferric dimethyl dithiocarbamate) and Manzate (manganese ethylene bis dithiocarbamate), E. I. duPont de-Nemours and Co., Inc.; Phygon XL (2, 3 dichloro- 1, 4-naphthoquinone), U. S. Rubber Co.; tribasic copper sulfate, Tennessee Copper Corp.; and Orthocide 406 (N-trichloromethylthiotetrahydrophthalamide), California Spray Chemical Corp.

Table 1. Relative effectiveness of various fungicides in control of scab on leaves and fruit, Lincoln, Delaware, 1950.

Materials[a]	Concentration in 100 gals. water	Infection (percent)[b] Leaf	Fruit
Check	---	52	100
Bordeaux mixture	4 lbs.-4 lbs.	0	1
Puratized Agricultural Spray	1 pt.	0	2
Fermate	2 lbs.	2	14
Liquid lime sulfur	6 qts.	4	80
Phygon XL	1/2 lb.	4	99
Magnetic 70 sulfur	7 lbs.	25	100

[a] Fungicides applied: April 20; May 1, 10, 18, 31; June 16; July 11, 20; Aug. 4, 28.
[b] From a random sample of 500.

The experiment was so designed that direct comparisons of relative effectiveness could be made of all materials applied at ten-day intervals (including Bordeaux mixture and Fermate).

In general, disease control was not so good in 1951 as in the previous year. This was particularly noticeable with Bordeaux mixture and, even more so, with Fermate. Control by Puratized Agricultural Spray, though not so good as in 1950, was adequate. Control with tribasic copper sulfate closely approximated that with Bordeaux mixture. Manzate and Orthocide 406 were considerably less effective from the standpoint of disease control on fruit.

With respect to the effect of timing of applications on control, both Bordeaux mixture and Fermate were more effective when used at ten-day intervals.

Injury of the same type and of approximately the same magnitude as in 1950 was again caused by Bordeaux mixture and Puratized Agricultural Spray in 1951. Tribasic copper sulfate caused injury similar in type and severity to that of Bordeaux mixture. Manzate and Orthocide 406 were apparently non-phytotoxic.

1952 Test: Although precise data were not obtained in 1950 and in 1951, observations indicated that the early, closely-timed applications were the critical ones in regard to disease control. Accordingly, the test in 1952 was designed primarily to gain more information on the effect of early applications on subsequent disease development.

One objectionable and sometimes unavoidable variable in such timing work is that of reinoculation of plots by means of spores carried in from the outside. To reduce this potential hazard, the more effective fungicides (Puratized Agricultural Spray and Bordeaux mixture[3]) were used. Also, all shrubs in the test area were treated with one or the other of these materials. Untreated infected plants approximately 300 yards distant served as checks.

[3]The concentration of Bordeaux mixture was twice that used in previous years in the expectation of obtaining more lasting protection.

Table 2. Relative effectiveness of various fungicides, and effect of application timing in control of scab on leaves and fruit, Lincoln, Delaware, 1951.

Materials	Concentration in 100 gals. water	Frequency of application (days)[a]	Infection (percent)[b]	
			Leaf	Fruit
Check	---	---	67	99
Puratized Agricultural Spray	1 pt.	10	7	14
Tribasic copper sulfate	3 lbs.	10	25	19
Manzate	1 1/2 lbs.	10	28	34
Orthocide 406	1 1/2 lbs.	10	31	48
Bordeaux mixture	4 lbs.-4 lbs.	10	24	20
	4 lbs.-4 lbs.	20	34	31
	4 lbs.-4 lbs.	30	27	56
Fermate (ferbam)	2 lbs.	10	35	55
	2 lbs.	20	46	81
	2 lbs.	30	62	81

[a] First application on May 1. The 10-day-interval series received a total of 12 applications, the 20-day-interval series, 6 applications, and the 30-day-interval series, 4 applications.
[b] From a random sample of 500.

The test area was divided into four equal blocks, two of which, selected at random, were treated with Puratized Agricultural Spray, the other two with Bordeaux mixture. Each block was further divided into three sub-plots. All of the sub-plots were treated with the proper material on April 29 and, again, on May 14 (blossom period). Two of the sub-plots in each block received a third application on May 27 and one, a fourth application on July 11. Results are shown in Table 3. These data indicate that the first two applications were probably the critical ones, although a third and even a fourth application produced additional beneficial results. Puratized Agricultural Spray was more effective than Bordeaux mixture.

Fruit again failed to color properly where shrubs received Puratized Agricultural Spray applications after fruit set (three or more applications). Injury by Bordeaux mixture was much less pronounced in 1952 than in preceding years.

DISCUSSION

Puratized Agricultural Spray and Bordeaux mixture gave good control of Pyracantha scab over the three-year test period. Puratized Agricultural Spray was generally more effective than Bordeaux mixture. All remaining materials, save possibly tribasic copper sulfate, were less effective than the above two materials in controlling this disease.

Timing appeared to be more important than the total number of applications. Three to four early applications of either Puratized Agricultural Spray or Bordeaux mixture in 1952

Table 3. Effect of timing and number of fungicide applications on disease incidence on leaves and fruit, Lincoln, Delaware, 1952[a].

Materials	Concentration in 100 gals. water	Number of applications	Infection (percent)[b]	
			Leaf	Fruit
Check	---	---	43	100
Puratized Agricultural Spray	1 pt.	2	2	12
		3	0	4.4
		4	0.4	0.7
Bordeaux mixture	8 lbs.-8 lbs.	2	6	18.6
		3	2	7.4
		4	1	4.8
L.S.D. .05			1.0	0.3

[a] Dates of fungicide applications: April 29, May 14, May 27, and July 11.
[b] From a random sample of 500 from each of two replications.

effected as good control as had many more in previous years.

A point of particular interest was that of the failure of Bordeaux mixture to cause serious injury in 1952. This was undoubtedly due in part to the abbreviated schedule (two to four applications), but another point not to be overlooked is the fact that hot dry weather prevailed during a considerable portion of the summer of 1952. This would tend to reduce the danger of injury from Bordeaux mixture.

Since Puratized Agricultural Spray is a soluble mercury compound with, consequently, poor tenacity, and since early applications showed lasting control over the entire season, it would appear that the action of this material is primarily that of eradication. The eradicative property of soluble mercury materials is well known (3, 4). This suggests the possibility of employing Puratized Agricultural Spray in pre-blossom applications for Pyracantha scab control, thereby possibly avoiding danger of fruit injury.

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RESULTS OF 1952 TESTS WITH FUNGICIDE MIXTURES FOR THE CONTROL OF APPLE SCAB AND QUINCE RUST[1]

D. H. Palmiter and F. H. Emerson[2]

The use of fungicide mixtures on apples has been a common practice in the Hudson Valley for several years where it is necessary to protect apple trees from cedar-apple or quince rust (Gymnosporangium juniperi-virginianae, G. clavipes) as well as apple scab (Venturia inaequalis). Sulfur-ferbam mixtures are commonly used in this connection. Such mixtures not only gave excellent control of the rust diseases but also showed improved scab control compared with the control obtained with either fungicide used alone.

The idea for further improving apple scab control by mixing eradicant and protectant types of fungicides appeared promising in previous field experiments. Some mixtures proved to be more compatible and complementary than others. Certain mixtures increased the danger of host injury while others appeared to reduce it. Half doses of two different fungicides were often less injurious than a full dose of either one. Some mixtures were too expensive to be practical while others were quite economical, considering the improved disease control and fruit finish.

The results of combinations tested in 1952 show typical reactions between certain fungicide combinations. McIntosh, Cortland, Delicious, and Golden Delicious varieties were in the experimental orchard but not all varieties were available for each treatment. The fungicides were mixed in the spray tank and arsenate of lead was used as the insecticide, with all of the treatments starting with the petal-fall application. Sulphenone 50-W was added at the rate of 2 pounds per 100 gallons in the fourth cover spray for mite control. The differential treatments started with the green-tip spray and carried through the first cover on June 2. All plots, with the exception of one 406 plot, were then sprayed with Fermate in the following

Table 1. Apple spray schedule in relation to infection periods. Rock City, New York. 1952.

Spray schedule[a]	Date applied	Primary infection periods			
		Rain began	Trees wet	Temperature	Rainfall
			(hours)	(°F)	(inches)
		April 13	36	45	0.55
Green-tip	April 14				
Delayed dormant	April 22				
		April 24	64	55	1.20
		April 27	41	56	0.84
Pre-pink	April 28				
Pink	May 3				
		May 10	45	52	1.43
Petal-fall	May 14				
		May 17	18	54	0.19
		May 20	38	54	0.48
Special	May 22				
		May 25	56	60	1.15
		May 29	14	55	0.35
		June 1	22	64	3.43
1st cover	June 2				

[a] Fermate 1 1/2-100 was used in the 2nd to 5th cover on all but one 406 plot, and the spray dates were June 13 and 23 and July 7 and 23.

[1]Approved by the Director for publication as Journal Paper No. 915, New York State Agricultural Experiment Station, Geneva, New York, November 28, 1952.

[2]New York State Agricultural Experiment Station, Poughkeepsie; and Stauffer Chemical Company, New York City, respectively.

Table 2. Results of fungicide mixtures on scab and quince rust control on apple. Rock City, New York. 1952.

Fungicide treatment[a]	Percent infection					
	McIntosh		Cortland		Delicious	
	Scab	Russet	Scab	Rust	Scab	Rust
Magnetic "70" sulfur 6-100[b]	64	--	--	--	--	--
Phygon-XL 1/2-100	3	10	--	--	--	--
Magnetic "70" & Phygon 1 oz. 4-100	26	9	--	--	--	--
Magnetic "70" & Phygon 2 oz. 4-100	5	16	--	--	--	--
Magnetic "70"-Phygon-XL 4-1/4-100	9	11	--	--	--	--
Crag 341-Lime 3 pts.-1/2-100[c]	22	9	15	4	53	6
Coromerc[d] 1/2-100	5	4	6	3	9	4
Crag-Coromerc 1 1/2-1/4-100	9	10	7	7	6	5
Fermate 1 1/2-100	15	6	8	0	10	0
Fermate-Coromerc 3/4-1/4-100	2	6	3	tr.	--	--
Phygon-XL 1/2-100	3	10	3	1	--	--
Fermate-Phygon-XL 3/4-1/4-100	3	4	--	--	1	0
Fungicide 406[d] 2-100	2	5	2	1	1	1
Fungicide 406 2-100 & 1-100[e]	1	2	1	1	1	1

[a] Fermate 1 1/2-100 was used on all plots (except one 406) in 2nd to 5th covers.
[b] Magnetic "70" concentration was reduced to 4-100 after bloom.
[c] Crag 341 concentration was reduced to 1 1/2 pts. after bloom.
[d] Fungicide 406 = 50% active N-trichloromethylthio-tetrahydrophthalimide, Coromerc = 10% active N-phenylmercuriethylenediamine.
[e] Fungicide 406 was used all season at 2#-100 early and 1#-100 in covers.

Table 3. Russet injury on Golden Delicious in relation to the use of fungicide mixtures in 1952.

Fungicide treatment[a]		Percentage of fruit			
		None	Slight	Moderate	Severe
Fungicide 406	All season	78	19	3	0
Fungicide 406	Fermate in cover	25	53	21	2
Phygon-XL	" " "	24	46	27	3
Coromerc	" " "	10	52	37	1
Crag 341	" " "	11	51	37	2
Crag-Coromerc	" " "	11	47	40	3
Magnetic "70"-Phygon 1 oz.	" " "	1	24	69	6

[a] Arsenate of lead 3-100 was used with all treatments starting with the petal fall application. Sulphenone 50-W was added to fourth cover spray for control of red and two-spotted mites.

cover applications. In order to determine the value of the mixtures, the applications were made at approximately weekly intervals without regard to the occurrence of infection periods. Conditions were favorable for scab infection this season, and nine infection periods occurred during April, May, and early June when the differential treatments were being used (Table 1).

Under the conditions of this experiment protectant fungicides, including Magnetic "70" sulfur paste, Fermate, and Crag Fungicide 341, averaged 64, 15, and 22 percent fruit infection respectively. Under the same conditions, fungicides with some eradicant properties, including Phygon XL, Coromerc, and Fungicide 406, averaged 3, 5, and 2 percent fruit scab respectively. Phygon, however, caused considerable fruit russet, and Coromerc failed to control quince rust on Cortland and Delicious trees and caused serious leaf injury. Fungicide 406 looked promising and may come into general use.

Several combinations of Magnetic "70" paste and Phygon were included in the experiment. Phygon was wet ground and formulated with the sulfur paste at the rate of 1 and 2 ounces in a 4 lb. unit of paste. The 1 ounce mixture at 4-100 resulted in 26 percent fruit scab and the 2 ounce mixture showed 5 percent scab but increased the amount of fruit russet on McIntosh from 9 to 16 percent. The tank mixture of sulfur with Phygon XL 4-1/4-100 resulted in 9 percent scab and 11 percent russet. Cortland trees were not available in the sulfur-Phygon plots so quince rust data were not available. Under the conditions of this experiment nothing was gained by mixing Magnetic "70" with Phygon, since the Phygon-XL at 1/2-100 afforded better scab control and caused less injury than the mixtures (Table 2).

A mixture of Crag 341 with Coromerc 1 1/2 pts. -1/4 lb. -100 resulted in 9 percent scab and 10 percent fruit russet on McIntosh and 7 percent quince rust on Cortland. Under the conditions of this experiment the mixture did not prove worth while.

Tank-mixed Fermate and Coromerc 3/4-1/4-100 resulted in better scab control (2 percent) than was obtained with either fungicide alone. Quince rust control on Cortland was as good as that obtained with Fermate alone. Leaf injury was less than with Coromerc alone and fruit russet was about the same as with Fermate alone (6 percent). Such ferbam-mercury mixtures may find a place in the early season apple spray program in areas where both scab and rust diseases are serious problems. They would be of special value to those growers who cannot cover their orchards quickly enough to use a protectant fungicide schedule.

Fermate used with Phygon-XL at 3/4-1/4-100 resulted in very good scab and quince rust control and caused less fruit russet than was caused by either fungicide used alone (Table 2). Similar results have been obtained with this combination used early in the season during the past four years. The Fermate seems to act as a safener for the Phygon and the Phygon greatly improves the scab control.

Fungicide 406 at 2 lbs. -100 showed both protectant and eradicant properties in this experiment and performed in a manner similar to that of the better fungicide mixtures. Where it was used throughout the season it showed better fruit finish than any other treatment on the Golden Delicious variety (Table 3). Where 406 was followed by Fermate in the last three cover sprays the fruit finish was about the same as that obtained with the straight Fermate program, indicating that this injury occurred in June and July when the highest temperatures prevailed. Quince rust control with 406 on Cortland and Delicious varieties was not significantly different from Fermate in this test, and both varieties showed better control than that obtained with Coromerc or Crag. Fungicide 406 would be expected to give commercial control if applications were well timed but other tests indicate it is not the equivalent of Fermate for rust control.

In conclusion, the 1952 experiments with fungicide mixtures in general confirm the results of previous tests. Under Hudson Valley conditions, Phygon-Fermate combinations have given much better results than Phygon-sulfur combinations. Fermate-mercury mixtures, when confined to the cool early season applications, have provided good apple scab and rust control without serious injury. Crag-mercury combinations are not suitable for the Hudson Valley since they do not control the rust diseases. Fungicide 406 may reduce the need for these mixtures if further tests substantiate its 1952 performance.

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A RAPID METHOD FOR MASS INOCULATION OF PEAR TREES WITH THE BLIGHT ORGANISM

John C. Dunegan, H. H. Moon, and R. A. Wilson[1]

In connection with the pear-improvement program at Plant Industry Station, Beltsville, Maryland, 1,732 pear seedlings from 31 crosses[2] of known parentage were inoculated with the pear blight organism (Erwinia amylovora) in 1951, when the trees were nine years old.

Typical pear blight symptoms developed on 900 trees and by mid-summer 324 trees were severely blighted. The trees showed four types of response, as follows:

No Blight:	Trees remained free of infection
Spur Blight:	Trees in which the bacteria did not advance beyond the base of the blossom spur.
Twig Blight:	Trees in which the bacteria invaded only one-year old wood of twigs and small branches.
Severe Blight:	Trees in which the bacteria invaded the older wood, killing large limbs or even the entire tree.

These catagories involve only the type, not the number of infections. For example, a tree with ten spurs invaded would be placed in the same class as a tree with only one spur infected.

The severely blighted trees, along with a number of other weak trees, were removed in the fall of 1951. In 1952 the inoculation was repeated on the 961 trees that remained. Environmental conditions favored the rapid spread of the organism in the host tissues. Severe cases of blight developed on 308 trees in 1952. These were removed in the fall of 1952.

The extent of infection during the 2 years was as follows:

	1951	1952
Trees not infected (percent)	48	43
Trees with only spurs infected (percent)	5	5
Trees with twigs infected (percent)	28	15
Trees severely infected (percent)	19	37

The blight infections were obtained by using a power sprayer and gun to drench, at a pump pressure of 550 pounds per square inch, one side of each tree with an aqueous suspension of E. amylovora and finely divided pyrophyllite. To compensate partially for differences in development of the individual trees they were inoculated twice during the blooming period each spring. It took only 1 to 1 1/2 hours each time to inoculate the entire planting.

No attempt has been made to standardize the procedure, for the main purpose of the experiment is to determine the ability of the various trees to resist the invasion by pear blight bacteria in spite of the tiny wounds made by the abrasive. Accordingly, the inoculum used on April 25, 1951, consisted of the bacterial growth (72 hours old) washed from 100 beef-extract-agar slants suspended in 600 gallons of water plus 30 pounds of pyrophyllite. On May 7 the bacterial growth from 400 agar slants was suspended in 600 gallons of water and 60 pounds of pyrophyllite was added as the abrasive. In 1952 the work was simplified by growing E. amylovora in beef-extract broth. On April 29 the inoculum was prepared by pouring 4 liters of the broth culture into 600 gallons of water and then adding 60 pounds of pyrophyllite, while on May 12 the inoculum consisted of 6 liters of the broth culture and 15 pounds of pyrophyllite in 600 gallons of water. The discs in the spray gun had a 12/64-inch aperture in 1951 and a 10/64-inch opening in 1952.

It would be premature to attempt any evaluation of the various crosses at the end of only two seasons. However, 632 trees have been eliminated because of their susceptibility, and 253 trees have remained free of blight infections for two years.

Inoculation tests will be continued until it is found 1) that all the trees eventually are severely infected; 2) that the organism will not spread, or "run", in certain infected trees; or 3) that some trees cannot be infected and must be considered immune.

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[1] M. C. Goldsworthy, formerly of the Bureau of Plant Industry, Soils and Agricultural Engineering, also worked on this project in 1951.

[2] Erroneously reported as "... 1,739 pear seedlings from 29 crosses..." in a preliminary abstract (Phytopathology 42:341, 1952).

One of the difficulties in testing the susceptibility to E. amylovora of a large number of pear trees is the time required to inoculate each tree. Since only succulent twigs are susceptible, speed is essential lest some of the trees become non-succulent before they can be inoculated. The method of mass inoculation with a power sprayer described in this note largely overcomes this difficulty. With this procedure it is feasible to expose almost simultaneously a large number of trees to bacterial invasion. This should lead to a more precise test of the susceptibility of a large number of trees than hitherto was possible with the time-consuming hand-inoculation procedures.

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"SPRING CANKER" OR "BLACK TIP"? OF PEACH TREES

H. W. Anderson

I read with interest the account of Goldsworthy and Wilson (1) in which they confirmed the development of a definite type of infected area on the peach twig, which we called "spring canker" in Illinois (2). I have never been satisfied with this name, since the term "canker" is not definitely descriptive of the invaded area, especially in the early stages of its development. On the other hand, the proposed change to "black tip" is still less appropriate.

Workers in Illinois have studied this phase of the bacterial spot problem almost every season for the past 22 years. We have recognized the "black tip" type, which we have designated as "terminal die-back". By no means all of these die-backs are the result of bacterial invasion. This is evidenced by the fact that trees having no bacterial spot during the previous or the succeeding season have about as many die-backs as trees heavily infected in the preceding season. It is often possible in the spring to distinguish between die-backs that harbor Xanthomonas pruni and those which will not yield this organism. For several seasons we classified the location of the spring cankers on several hundred twigs as to whether they were terminal, internodal, or nodal. It was usually necessary to discard over 90 percent of the twigs showing terminal die-back as not containing any live bacteria when examined microscopically or when cultured. It is usually possible after some experience to select twigs in the field that are likely to yield live bacteria. These do not have a sharp line of demarcation between the dead and living tissue, as is the case where the die-back is caused by other factors. It is true that twigs weakened by defoliation resulting from attack by X. pruni are often subject to die-back, but they are not necessarily invaded by the bacteria.

Another argument against the use of the term "black tip" is that these lesions often are neither black nor do they develop at the tip of the twig unless one regards the "tip" as the terminal half of the current season's growth. Our records show that in some seasons about 50 percent of the invaded areas are found at or near the terminal bud or subtending a short terminal die-back, whereas the other 50 percent are below the first or second lateral bud but on the upper or terminal third of the twig. In some seasons less than 25 percent are located at or near the terminal bud.

It is difficult to describe the invaded area on the basis of color. We have always had trouble getting good photographs of these areas because of lack of contrast. Also, it is difficult to train inexperienced helpers to recognize the cankers, especially when the lesions first become evident in the spring. (I myself missed about 10 percent of them my first time over a tree this spring when I was particularly anxious to find every lesion -- this after 22 years of experience). The best one can say is that the invaded area is a little off color, perhaps a little darker green on the green side of the twig and a little more purple on the purple area. There is at first no clearly defined border. It is true that the area darkens with age, but it never becomes black under Illinois conditions as is true of the summer cankers.

As regards the time of infection we have stated (2), "The time of twig infection is probably during rains before the infected leaves drop in the fall." The exact time and conditions under which this occurs has not been proved by definite experiments, except that in artificial inoculations made by needle puncture it was shown (2) that twigs inoculated in November developed evidence of bacterial invasion in the neighborhood of the punctures on the terminal portion of the twig by February 3 and April 15 of the following spring. Larsh and Anderson (3) proved that viable bacteria are present in the twigs during the winter months, by collecting twigs suspected of having been infected the previous fall and breaking their dormancy in the laboratory. Such twigs collected on February 6, 1941, developed typical spring cankers one week later. Cankers were not evident when the twigs were collected in the field.

The time when the spring cankers become visible in the late winter or early spring varies greatly from year to year under Illinois conditions. A few may be found in late March but they are more common in April. In 1952, a daily examination at Urbana of a group of five trees in which an unusual number of cankers developed during the season revealed the first evident cankers on April 7 just as the buds were bursting and the tips of the leaves were showing. In 1940 at Irvington, Illinois (latitude of St. Louis, Missouri) a weekly examination was made of several hundred trees (3). On April 22 and 29 no spring cankers could be found. On May 6, 12 spring cankers were found on the 569 trees in this orchard.

The term "black tip" might be appropriate to describe one type of symptom of the overwintering phase of the disease. Certainly I would not favor substituting "black tip" for "spring canker" as a descriptive name for the combined symptoms of this phase of the disease cycle.

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UNIVERSITY OF ILLINOIS, URBANA

NUT DISEASES IN OREGON IN 1952

P. W. Miller

Walnut Diseases

Walnut blight (Xanthomonas juglandis (Pierce) Dowson) was widely distributed in Oregon in 1952, causing greater economic loss than in 1951. Losses from this disease in non-sprayed orchards varied, according to the locality, from a negligible amount up to 35 percent. It is estimated that for the State as a whole about 8 percent of the potential walnut crop was destroyed by this disease in 1952.

Mushroom root rot (Armillaria mellea Fr.) caused the death of a few seedling Persian walnut trees in western Oregon in 1952.

Leaf scorch (non-parasitic). This leaf disorder was widely distributed in western Oregon in 1952, occurring to a greater or less extent in most Persian walnut orchards in the western part of the State. It was especially severe in orchards in the Roseburg (Oregon) district, causing a substantial decrease in the functional leaf area through death of the tissues.

Black-line (girdle) of grafted walnuts (non-parasitic). This disorder was responsible for the death of more grafted Franquette walnut trees in 1952 in Oregon than any other single cause. Its importance in the decline of grafted walnuts in this State was shown by the results of an individual tree survey made in 1952 in 34 widely scattered walnut orchards in western Oregon. In these 34 orchards, a total of 2213 trees were found declining, 48.4 percent of which were found declining from the effects of the black-line disorder. This trouble was widely distributed in Oregon, occurring to a greater or less extent in practically all walnut districts in the western part of the State. In general, incidence was greater in upland than in valley floor orchards. All trees found affected were of the Franquette variety grafted on Hind's black walnut rootstocks (Juglans hindsii), or on hybrids of other species with this one. Not a single case of black-line was found in Persian walnuts grafted on Persian seedling rootstocks.

Crown rot (cause undetermined). A crown rot of undetermined cause was found affecting a limited number of Persian walnuts grafted on Hinds' black walnut rootstocks in western Oregon. Most of the affected trees were located in upland orchards on "heavy" soil types.

Filbert Diseases

Bacterial blight (Xanthomonas corylina (Miller et al.) Dowson was widely distributed in western Oregon in 1952, causing greater damage than in 1951. It was especially prevalent in the northern part of the Willamette Valley, particularly in older orchards where it caused the death of many twigs.

Powdery mildew (Phyllactinia corylea Karst.) occurred to a greater or less extent in many filbert orchards in western Oregon in 1952. However, the disease was of no economic importance as it did not appear until very late in the season. The infected leaves retained their normal green color until the end of the season and persisted on the trees until time of normal fall.

Brown stain (non-parasitic) was present in limited amounts in some filbert orchards in western Oregon in 1952.

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PERCENTAGE OF STRAWBERRY PLANTS INFECTED WITH YELLOWS VIRUS COMPLEX BY SINGLE STRAWBERRY APHIDS

P. W. Miller

Several investigators (Prentice and Harris (3), Prentice (4), and Miller (2)) have carried on investigations on the number of strawberry aphids (Capitophorus fragaefolii (Ckll.)) required for the transmission of strawberry viruses. Apparently, no investigations have been conducted on the percentage of plants infected by single strawberry aphids. It is important to know this in relation to the dissemination of strawberry viruses and to their control. Experiments designed to obtain information on this question were carried on by the writer during 1952. A discussion of the methods used and of the results obtained follows.

Methods

Young and old wingless strawberry aphids from a colony which had developed for 58 days on a Marshall strawberry plant infected with strawberry yellows virus complex were transferred to healthy Fragaria vesca (East Malling strain) plants, only a single aphid being put on a plant. The aphids were closely watched for about 30 minutes thereafter to be sure that they were not fatally injured during transfer and were actually feeding on the indicator plants. After feeding for 5 days they were killed by fumigation.

Results

Table 1. Transmission of strawberry yellows virus complex by feeding of one strawberry aphid per plant.

Relative age of aphids	Plants Inoculated (number)	Plants Infected (percent)
Young	37	38
Old	43	33
Total	80	35

The results given in Table 1 would seem to indicate that the strawberry aphid is not such an efficient vector as certain other aphid vectors of viruses, an average of only 35 percent of the aphids being found infective. There was no substantial difference in the infective capacity of young and older strawberry aphids.

A number of other aphid vectors of viruses have been found more efficient as vectors. Thus, in one experiment Kirkpatrick and Ross (1) reported that 45 percent of the green peach aphids (Myzus persicae (Sulz.)) tested transmitted the potato leafroll virus. Watson (5) reported that 76 percent of green peach aphids transmitted the sugar beet virus (virus Hyoscyamus III) under optimal conditions.

There is no evidence to indicate that infectious and non-infectious strains of strawberry aphids exist. Rather, it seems more reasonable to assume that differences in the infective capacity of the aphids are related to the quantity of virus in the insect and to the dose received by the plant.

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TESTS OF WILD STRAWBERRIES FROM CALIFORNIA FOR VIRUS INFECTION

P. W. Miller

In previous papers (1, 2), the writer presented data indicating that wild strawberries belonging to the species F. ovalis and F. chiloensis may be important natural sources of virus infection in western Oregon but of only relatively minor importance east of the Cascade mountains. In a recent trip to California, G. F. Waldo collected plants of F. vesca and F. chiloensis from different clones from various localities within a mile of the beach along the California coast. Most of the plants collected were far removed from any cultivated strawberries. To ascertain whether or not viruses were present in these plants, they were runner-grafted to healthy F. vesca (East Malling strain) indicator plants. The results of these studies are given in Table 1.

Table 1. Tests of wild strawberries from the California coast area for the presence of viruses, 1951-1952.

Species and location	Plants	
	Tested (number)	Infected (number)
F. vesca		
20 miles N. of San Simeon,	6	0
F. chiloensis		
20 miles N. of Santa Cruz,	5	2
10 miles S. of Crescent City,	12	0
Total	23	2

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RED LEAF OF OATS

V. E. Wilson and H. C. Murphy

A generalized and severe outbreak of a disease known as red-leaf caused the loss of approximately 15 percent of Iowa's oat crop in 1949. Leaves of infected plants would begin to redden terminally and the color would then spread over the entire leaf. Severity of the disease ranged from complete recovery of the plant to complete blasting of the panicle.

It has long been known that pigmentary disorders were influenced by temperature, drainage and precipitation, and soil fertility. Observations indicated that soil type or drainage were not associated with the red leaf disease observed in 1949. Owing to the widespread environmental and soil fertility conditions over which the infection ranged, the possibility of these factors being the cause seemed precluded. However, differences in varietal reaction to the disease were striking.

Red leaf of oats is not a new disease, as evidenced by reports of Manns (1), McKinney (2, 3), Sprague (8, 9), and more recently by Oswald and Houston (4, 5, 6). It appeared in Iowa in epidemic proportions on oats in 1949 and in 1951 outbreaks occurred on barley in California. Its incidence has been negligible in Iowa for the past two years. Preliminary experiments at Ames, Iowa, in the greenhouse indicated that the red-leaf of oats transmitted by aphids does not produce a yellow dwarf of barley as was reported by Oswald and Houston (5).

Symptoms and Description of Red Leaf

In both the greenhouse and the field the infected plants developed the characteristic red color, matured earlier, had abnormally light-colored and low bushel-weight seed, and had more panicle blasting than normal.

A relationship between weather and red-leaf severity seemed indicated by the fact that warm, dry weather caused the red coloration of the leaves to become brown; the leaves became brittle, and the plants showed all stages of recovery from death to apparent normalcy.

Transmission Studies in the Greenhouse

Seed collected from red leaf plants was sterilized and sown in the greenhouse in sterilized soil in 5-inch clay pots. Untreated seed was sown as a check. All plants grew to maturity without symptoms, indicating that disease was not transmitted in the seed.

Soil from a field where red leaf infection was heavy was collected, put in flats, and sown to Marion oats. A few of the plants showed red leaf symptoms when about 12 inches in height. Subsequent oat seedlings in the same soil produced increasing numbers of infected seedlings, the successive fifth seeding producing completely diseased samples.

To confirm these findings, Marion and Cherokee oats were sown in infested soil and in steam-sterilized soil. Those in the infested soil produced the usual red leaf symptoms while those in the sterilized soil were normal in all respects. The disease was readily soil-transmissible, the infection becoming increasingly more severe as successive oat crops were grown.

The expression of red leaf symptom was reduced when nitrogen was added to greenhouse infested soil. The addition of super-phosphate or potash, or a combination of the two, had no evident effect on the amount of red leaf. Nitrogen in high concentration inhibited the expression of red leaf symptoms.

Failure of Mechanical Transmission

All attempts to transmit red leaf by inoculation with an aqueous suspension of infected plant juices, and by abrasion with a carborundum-plant juice paste, were unsuccessful in inducing a systemic infection. Small local lesions of temporary nature appeared around the points of injection and abrasion, but these soon turned brown and disappeared.

Aphid Transmission and Light-Temperature Interaction

Marion, Cherokee, and Victoria oats were each grown in a series of 6-inch clay pots. When the plants were six inches tall they were artifically infested with five apple-grain aphids, Rhopalosiphum prunifoliae (Fitch), per plant. The aphids had been cultured for five weeks on

red leaf-infected plants. A second series was infested with aphids that had been cultured on non-infected wheat and corn plants. A similar number of plants was kept free from aphids to serve as a control.

All plants infested with aphids cultured on red leaf-infected plants developed red leaf. A few plants infested with aphids from corn and wheat developed red leaf symptoms, while all of the plants free of aphids appeared healthy and normal.

Some infected plants, immediately after the leaves turned red, were left at a temperature of 50° to 70° F., but shaded from direct sunlight. The reddening was reduced. Additional pots, similarly infected, were left in direct sunlight, but removed to a temperature of 75° to 90° F. Browning of the infected areas resulted.

The red leaf condition was aphid transmitted. The expression of red leaf symptoms was inhibited by reduced light intensity and by temperatures of over 75° F. Conversely, high light intensity and low temperatures favored the expression of red leaf symptoms.

Varietal Differences

The amount of red leaf infection in 18 oat varieties and selections grown at Ames, Iowa, in 1951 was determined by counting the number of infected plants in an area one meter square in each of four replications. The analysis of variance, following the methods of Snedecor (7), was as follows:

Table 1. Analysis of variance of number of red leaf infected plants.

Source of variation	d.f.	S.S.	M.S.
Replicates	3	7.3	2.4333
Varieties	17	274.0	16.1176**
Error	51	148.2	2.9059

** Significant at .01 precent level.

The analysis of variance indicates that, under field conditions, a significant difference in varietal reaction to red leaf existed. Anthony-Bond x Boone, C. I. No. 5220, was the most resistant of the named varieties tested. Clinton x Marion, C. I. No. 5648 was the most susceptible. The average number of infected plants per square meter for these two varieties was 2.0 and 8.7, respectively.

Summary and Conclusions

As a result of the experiments conducted at Iowa State College the following conclusions about the red leaf disease of oats as observed in Iowa can be stated:

(1) It is a systemic disease, infective in nature.
(2) It is readily soil transmitted, but not seed-transmissible.
(3) Mechanical transmission of the disease has been unsuccessful.
(4) An insect vector is the aphid.
(5) A definite temperature-sunlight interaction is apparent, with low temperatures and direct sunlight favoring symptom expression of the disease.
(6) Differential varietal reaction to the disease was observed.

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COOPERATIVE INVESTIGATIONS BETWEEN THE IOWA AGRICULTURAL EXPERIMENT STATION; AND THE DIVISION OF CEREAL CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AGRICULTURAL RESEARCH ADMINISTRATION, THE UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL-BORNE WHEAT MOSAIC VIRUSES IN THE GREAT PLAINS

H. H. McKinney

The soil-borne wheat mosaic viruses were discovered in Illinois and Indiana in 1919. Later they were found in Virginia (1925), Maryland (1927), North Carolina (1929), and South Carolina (1944). Over the years, Illinois has had the widest distribution of soil-borne wheat viruses of any State. A recent publication (3) brings together much information on these mosaics in Illinois.

No studies were made on the mosaic from Maryland. Studies of the viruses in the soil infested areas in the other five States have indicated that the mosaic-rosette virus, Marmor tritici var. typicum (5), and the prairie wheat yellow mosaic virus, M. tritici var. fulvum (5), are at least the predominating wheat viruses present, though not all of the yellow mosaic viruses collected in these States, and which are regarded as strains of M. tritici, are identical in all particulars (6).

In 1944 (1) the occurrence of wheat mosaic was reported in Missouri, and from the recorded observations made in connection with a wheat mosaic survey in Illinois, it appears that the symptoms in Missouri were like those of the wheat mosaics occurring in Illinois.

Since the severe outbreak of wheat streak mosaic in 1949 (2), considerable attention has been given to the testing of soils from mosaic wheat fields for possible soil-borne viruses in the western prairies and Great Plains.

METHODS

Soils were collected in several counties in northcentral and northwestern Missouri in 1949 by Hurley Fellows; throughout Kansas from 1949 to 1952 by L. E. Melchers, Claude King, T. E. Brooks, Hurley Fellows, and the writer; in western Iowa in 1950 by H. C. Murphy and others; and in northcentral Oklahoma in 1952 by H. C. Young, Jr., and Dallas Wadsworth.

The soils were collected in amounts ranging from 1 to 20 quarts, usually not more than 2 quarts, and sent to Beltsville, Maryland, for testing. Most of the tests were conducted in 6-inch clay pots, which were packed in peat moss in 10-inch clay pots or in pails to protect the roots of the test plants from low winter temperatures. The plants remained out-of-doors until mid-January, when they were transferred to a cool greenhouse. The greenhouse night temperatures increased gradually from 55° or 60° F. to about 70° F. in late winter and early spring, with higher temperatures on sunny days. A few of the soils were tested during the summer in culture chambers held near 60° to 62° F. during the night with a daily photoperiod of eight hours. Mid-day temperatures rose to about 70° F. when the sun was bright.

Red winter spelt was used as the test plant because of its high sensitivity to infection by the known soil-borne wheat mosaic viruses. This is the only test plant found thus far that will express mosaic when plants are growing slowly out-of-doors in mid-November in a mild autumn and when the soil is highly infectious. In the same soil in concurrent tests, varieties such as Michigan Amber and Harvest Queen have not developed symptoms until growth was resumed in the spring, even though infection takes place in the autumn. Symptoms cannot appear when autumn temperatures drop rapidly in October and November, and the growth of the infected plants is essentially stopped. This also occurs in wheat infected with streak mosaic viruses from manual inoculations, and with all other virus diseases with which the writer has worked. Symptoms come to expression with a rise in temperature and the resumption of growth.

RESULTS

The great majority of the soils collected in Kansas proved to be from fields in which streak mosaic viruses were the causal agents, as shown from the inoculation tests made on the leaf samples that accompanied the soil collections. These viruses have never given evidence of over seasoning in the soil. The soil collection from Iowa was from a field in which both streak mosaic virus and soil borne virus were present. The counties in which the presence of soil borne wheat mosaic viruses was established by these tests, and the year that each soil sample was collected, are listed in the table.

Hodgeman County, Kansas, near the 100th meridian, is the farthest west that soil-borne wheat mosaic viruses have been collected. Except for those from Hodgeman and Pratt Counties, the active soil samples collected in Kansas are from the eastern half of the State, and most of them from the eastern fourth. The infested area in Oklahoma connects roughly with

Table 1. States and counties in the Western Prairies and Great Plains where collections of soil have been found to carry wheat mosaic viruses.

State	County	Year of collection	State	County	Year of collection
Iowa	Monona	1950	Kansas	Jackson	1950
				Labette	1952
Missouri	Chariton	1949		Lyon	1952
	DeKalb	1949		Pratt	1949
	Lafayette	1949		Shawnee	1950
				Sumner	1952
Kansas	Cherokee	1952		Wabaunsee	1950
	Cowley	1952		Wilson	1952
	Douglas	1950			
	Franklin	1952	Oklahoma	Blain	1952
	Greenwood	1952		Kay	1952
	Harvey	1952			
	Hodgeman	1949			

the infested area in southern Kansas. Clemson, South Carolina, is the farthest south soil-borne wheat mosaic viruses have been reported.

It has not been possible to study the viruses from each of the infested soils, but the tests with spelt indicate that light-green mottling and yellow mottling strains are present in all of the active soil samples. Also, all of the viruses that infected wheat via the soil, and that were tested by manual inoculations, failed to infect wheat when cultured at summer temperatures at Beltsville, but did infect manually inoculated wheat when cultured at cool temperatures. Some of the active soils from Kansas have been retested with the rosette susceptible selection of Harvest Queen wheat. Also, this variety of wheat has been manually inoculated from the mosaic spelt plants growing in the active soils. In no case has mosaic-rosette appeared in these soil re-tests nor in the manual inoculation tests. However, light green mosaic has developed in some of the Harvest Queen plants, and similar symptoms appeared in Michigan Amber wheat. These light green symptoms are indistinguishable from those induced in Michigan Amber wheat by the mosaic rosette virus. Also, they bear a very close resemblance to the symptom induced in Michigan Amber and in Harvest Queen wheats by non-rosetting green-mosaic viruses isolated from infected wheat growing in infested soils from mosaic-rosette virus infested fields (6). Furthermore, these light green mosaic symptoms are not clearly distinguishable from those induced by the plains wheat green-mosaic virus, Marmor campestre var. typicum (5), designated earlier as wheat virus No. 4 (4).

When the plains wheat mosaics were discovered, samples of the soils were tested at Arlington Farms, Virginia, and found to be inactive. At that time these mosaics were very limited in Kansas. With the finding of soil borne, non-rosetting, light green mosaic virus in Kansas, it now seems possible that the plains wheat mosaic viruses actually over season in the soil, and that this relationshp was not detected in the original tests because of low incidence of virus in the soils.

Unfortunately, the plains wheat mosaic viruses were lost during the summer of 1942 when cool-temperature chambers were not available for maintaining the cultures. This precludes the making of comparative studies that could clear up the matter of virus identity based on type viruses. It is quite possible that some of the wheat mosaic viruses requiring cool temperatures for infection from manual inoculations do not over season in the soil. However, until it is possible to obtain natural infection through the soil with isolates of Marmor tritici introduced into soil, some of these questions will remain unanswered. All attempts to obtain infection from soils to which these isolates were introduced and allowed to overseason, have met with failure.

Further study is required to determine if the mosaic-rosette virus occurs in Missouri, Kansas, Iowa, and Oklahoma. The question of placing all of the soil-borne wheat mosaic viruses in the species Marmor tritici cannot be settled until comparative studies have been made of

the several properties of virus isolates from the different regions of incidence.

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DIVISION OF CEREAL CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

A SOIL-BORNE WHEAT MOSAIC VIRUS IN OKLAHOMA

D. F. Wadsworth and H. C. Young, Jr.

Soil-borne virus diseases of wheat have been known for many years in the eastern soft red winter wheat growing areas (1), and more recently the same or similar soil-borne viruses have appeared in the western prairies and Great Plains (2). This paper deals with soil-borne mosaic viruses of wheat found for the first time in Oklahoma during the 1952 season.

In mid February 1952, an unusual condition was observed in three wheat fields in southwestern Kay County, Oklahoma. When first observed, large yellowish spots approximately 20 yards in diameter with well defined margins in otherwise healthy green wheat were clearly visible in two fields, whereas the other field appeared to be rather uniformly chlorotic. The affected spots were quite yellowish, changing abruptly into a healthy green color at the margins. Many of the plants were chlorotic, stunted and poorly tillered, indicative of symptoms sometimes associated with nitrogen deficiency.

Close examination of individual plants, however, showed that the chlorotic areas of the leaves were irregular and contained green spots and broken green or purplish lines, which are not characteristic of nitrogen deficiency symptoms. Neither were the symptoms typical of those caused by any of the wheat streak mosaic viruses, which have occurred in Oklahoma for several years. Regardless of the dissimilarity of symptoms, an attempt was made to transmit the disease in the manner usually employed for the transmission of the streak mosaic viruses. All such attempts were unsuccessful.

Near the end of February, when numerous reports were received that this condition was widespread, additional surveys were made through Major, Blaine, Alfalfa, Grant, Kay, Ottawa, and Payne Counties in north-central Oklahoma where at least 29 fields were found to be affected.

During these surveys it was noted that the disease occurred on upland sandy soils as well as on the heavier bottom lands. Most of the damage, however, was found in lowland fields which had been flooded several times during the summer and early autumn of 1951. In addition, the severity of symptom expression and prevalence of affected plants seemed to be closely correlated with tillage practices and certain cropping systems. The disease was more severe where adequate seedbeds had not been prepared at planting time, and also in fields where a continuous wheat cropping system without the addition of fertilizers had been followed. Conversely, in fields where the wheat crop had followed a legume the previous season, or where adequate fertilizer had been applied, the disease was absent or much less severe.

Thus it appeared that some nutrient deficiency, possibly nitrogen or phosphorus or both, might be the cause. To test this hypothesis, plants from affected fields were brought to the greenhouse and potted in soil to which a complete fertilizer had been added. In a few days under optimum conditions the chlorosis was reduced considerably in degree, and a vigorous growth ensued. However, the light and dark green mosaic pattern continued in the new leaves. A further attempt was then made to transmit this condition manually to healthy wheat, again without success.

By mid-March, higher temperatures and ample moisture had promoted spring growth and the spots in the affected fields were less pronounced. Affected plants had made some growth and were less chlorotic, although a mottled, mosaic-type pattern remained in the leaves.

In fields that were more uniformly affected there was very little growth, and the fields had an over-all unhealthy bronze coloration.

During late March, H. H. McKinney, Senior Pathologist, Bureau of Plant Industry, Soils and Agricultural Engineering, visited the affected area and indicated that the symptoms were very similar to those caused by the soil-borne types of mosaic viruses.

Plants having these symptoms, together with soil samples from affected fields, were collected and taken to the Plant Industry Station, Beltsville, Maryland, where transmission tests at cool temperatures (60° to 65° F.) gave positive results, both from plant material and from soil samples. The results of McKinney's tests, shown in Table 1, indicate the virus nature of the disease and the association of the virus or viruses with the soil, at least in some of the fields.

However, further study will be required to determine if the soil-borne virus or viruses in Oklahoma are the same as those occurring in the Eastern areas.

By mid-April, healthy wheat was in the jointing stage and growing vigorously throughout the mosaic area. While the plants in mosaic-affected spots were somewhat stunted and retarded, giving the fields an uneven, ragged appearance, color differences due to chlorosis of

Table 1. Percent of infection resulting from manual inoculations of Michigan Amber wheat and from soil samples using Red Winter Spelt wheat. Both tests were controlled at 60° to 65° F.

Field designation	Manual inoculation percent infection	Soil samples percent infection
No. 1	----	66.6
2	----	12.5
3	22.4	0.0
4	----	0.0
5	8.3	66.6
6	20.0	20.0
7	6.8	----
8	23.7	----

Table 2. Comparisons of grain yield and test weight from healthy and mosaic areas. Paired areas were in the same field, and contiguous as nearly as possible. All fields were in a continuous wheat program, with no fertilizers.

Field	Replication no.	Yield in bu./acre		Test weight lbs./bu.	
		Healthy	Mosaic	Healthy	Mosaic
No. 1 Var. Wichita	I	25.5	11.5	62.0	58.5
	II	30.3	12.4	60.5	59.5
	III	31.8	10.5	59.5	58.0
	Average	29.2	11.4	60.6	58.6
No. 2 Var. Early Triumph	I	48.4	32.2	62.0	61.0
	II	51.4	22.2	62.5	61.0
	III	54.9	30.0	62.0	62.0
	Average	51.5	28.1	62.1	61.3
No. 3 Var. Pawnee	I	36.7	25.3	62.3	61.0
	II	30.9	25.2	62.0	62.0
	III	39.4	22.0	62.5	58.5
	Average	35.6	24.1	62.2	60.5

infected plants had largely disappeared. Where infection was severe, and whole fields were involved, very little growth had been made even at this late date. It appeared that some fields would be almost a total loss.

As the season progressed the symptoms changed rapidly, with little consistency among fields except that under favorable conditions recuperation was very marked.

In some severely affected fields the plants headed almost normally, though somewhat late, and were definitely stunted. Other fields less severely affected were very ragged, the plants varying as much as 12 to 18 inches in height between the healthy and diseased spots.

Sometimes entire spots of infected plants produced a few late tillers with small, shriveled seed, or failed to head at all.

An excellent growing season following a rather mild winter produced a bumper wheat crop in Oklahoma in 1952, yet many growers in the mosaic area received less than average yields.

To obtain some information on yield, paired plots of diseased and healthy areas were staked out in several fields, and were harvested for yield and test-weight comparisons. The results are tabulated in Table 2. In all cases the yields of the diseased plants were reduced. In the most severe cases the losses approached 50 percent, and test weight also was reduced.

In one field near Tonkawa, Oklahoma, where the entire field was affected, yield and test weight comparisons were made between fertilized and non-fertilized plots. The fertilized plots received 43 pounds of ammonium nitrate to the acre in April. The results of this test are shown in Table 3. The fertilizer application produced a small increase in yield; but apparently it was applied too late and possibly in insufficient quantity to be of great benefit.

Table 3. Results of yield and test weight measurements between fertilized and non-fertilized plots in a field of Pawnee wheat uniformly affected with a soil-borne mosaic disease.

Replication number	Yield in bu./acre		Test weight lbs./bu.	
	Fertilized	Non-Fertilized	Fertilized	Non-Fertilized
I	23.4	18.5	60.0	61.0
II	21.9	19.2	60.0	61.5
III	19.6	19.8	60.0	60.5
Average	21.6	19.1	60.0	61.0

It seems likely that the application of the fertilizer induced many small, late tillers to head, thus increasing the yield but at the same time producing late heads that were immature at harvest time and therefore reduced the test weight.

Direct comparisons of the effect of this disease on different varieties could not be made, but tests on varietal reaction, both in fields affected last season and in the greenhouse using soil samples from affected fields, are now under way. In view of its widespread occurrence and the serious losses encountered in some fields, this disease is worthy of considerable attention.

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DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, OKLAHOMA AGRICULTURAL EXPERIMENT STATION

SYMPTOM EXPRESSION OF THE WHEAT STREAK-MOSAIC VIRUS DISEASE AS AFFECTED BY TEMPERATURE[1]

W. H. Sill, Jr., and H. Fellows[2, 3]

McKinney (1) has shown that temperature differences alter symptom severity in several cereal viruses, including the wheat streak-mosaic virus (1, 2), but neither a systematic study of the effect of temperature upon this latter virus under controlled conditions nor any correlation of temperature with the intensity of field symptoms has come to the attention of the authors. Such information is needed to interpret and predict the varying behavior of this disease in both field and greenhouse.

Materials and Methods

Five wheat varieties, Lee, Rival, Marquis, Westar, and Michigan Amber, were planted in 6-inch pots under winter greenhouse conditions at 77° F. and grown from November through March at Madison, Wisconsin. At the two-leaf stage the plants were thinned to six per pot and then placed in five temperature groups of five or more pots each. The air and soil temperatures for the first four groups were 82° F., 75°, 68°, and 60°. The fifth was held at an air temperature of 60° and a soil temperature of 46° F. All groups were maintained at their respective temperatures one week prior to inoculation. They were inoculated by a finger-wiping carborundum method (2) with a 1-5 dilution of the yellow strain of wheat streak-mosaic virus, Marmor virgatum var. typicum McK., obtained from artificially inoculated Westar wheat. After inoculation, all groups of plants were maintained at the above temperatures unless specified otherwise.

Notes taken included incubation period for the mosaic, severity of leaf symptoms (yellowing, streaking, and mottling), and plant height. The above experiment was repeated three times.

Results Obtained

The incubation period was shortened appreciably by warm temperatures. In the three experiments the average incubation period was 5 days at 82° F., 7 days at 75°, 9 days at 68°, 15 days at 60°, and 23 days when the air temperature was 60° with a 46° soil temperature. In other experiments at Manhattan, Kansas, in the greenhouse, temperatures rarely dropped below 80° F. at night and were always 95° or more during the day during a very hot period. Under such conditions the incubation period usually was seven or eight days, indicating that the period between inoculation and symptom expression may increase slightly when temperature rises well above 82° F. McKinney (2) also reported that warm temperatures decreased the incubation period. With the same strain of the virus he reported an incubation period of 13 to 30 days at 60° F. with an eight-hour daily photoperiod. In another publication (1) he also noted longer incubation periods at lower temperatures.

Severe symptoms on all varieties appeared first at 82° F., next at 75°, then at 68°, and finally, two months after inoculation, at 60°. No marked masking of symptoms was observed at the three lower temperatures, but masking was evident at 82° even though slight mosaic symptoms were still discernible on some leaves at the end of a two-month observation period. In the experiments at the high temperatures at Manhattan, Kansas, mosaic symptoms generally were not severe and masking was relatively rapid. However, some symptoms remained on a few leaves throughout the period of observation even at these very high summer temperatures. At 60° F. air temperature with a 46° soil temperature, the Marquis, Westar, and Michigan Amber varieties finally developed clear symptoms, but Lee and Rival did not, although infective inoculum was obtained from these plants. When shifted to a 75° temperature, the latter two varieties developed clear symptoms on new accelerated growth. The Marquis

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[3]The writers wish to thank the Department of Plant Pathology at the University of Wisconsin for furnishing greenhouse space for this project and technical assistance by Gordon Grimm and Eugene Herrling.

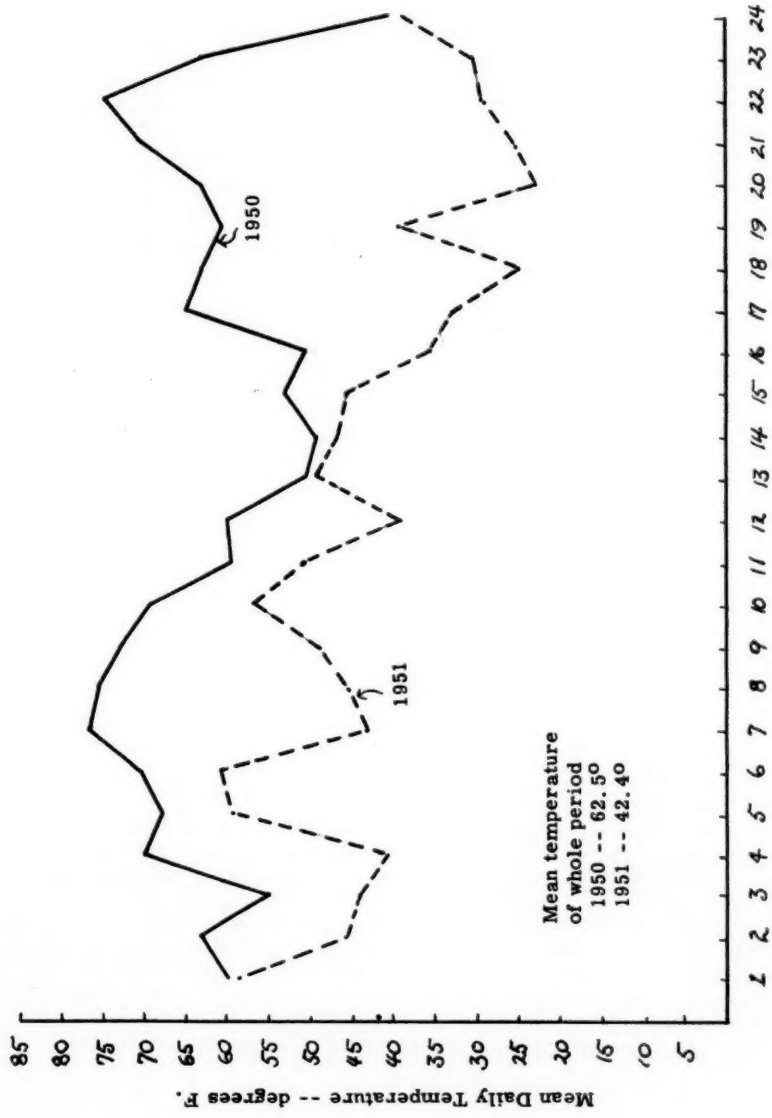

FIGURE 1. Mean daily temperatures after inoculation during the falls of 1950 and 1951. Symptoms did appear before dormancy in the warm fall of 1950 but did not appear in the cooler fall of 1951.

variety likewise showed growth acceleration and the development of more severe symptoms on the new leaves when shifted to 75°. McKinney (1), working with the Harvest Queen variety and the mild or green strain of virus, found the symptoms less severe at 60° F. with an eight-hour photoperiod than at 70° to 75° with a 14- to 15-hour photoperiod. He also noticed (2) that symptoms generally were more severe between 60° and 73° than when the daily maximum and minimum temperatures remained about 90° and 70°, respectively.

The growth and vigor of all inoculated and control plants were affected by temperature. The optimum was 68° to 75°, depending upon the variety. Below 68° the growth rate was slower but the plants were vigorous and the leaves normal. The optimum growth temperature for all varieties tested was below 82° F.

As shown by Table 1, stunting by virus attack was much more marked at the three higher temperatures. At the coolest temperature few virus symptoms and little, if any, stunting were evident one month after inoculation. Marquis was stunted more than any other variety at all temperatures except 68° F., and generally showed more severe leaf symptoms than any other variety. The percentage of stunting and the severity of leaf symptoms in each variety usually were closely associated. The averages of all varieties indicated 20.4 percent stunting at 75° F., 18 percent at 82°, and 16 percent at 68°. By contrast it was only 3 percent at 60° after one month and 4 percent after two months at 60° with a 46° soil temperature.

Table 1. Stunting of plants of five wheat varieties at five temperatures, one month after inoculation with wheat streak-mosaic virus.

Temperatures °F	Reduced height compared with uninoculated plants (Percent)				
	Rival	Lee	Marquis	Westar	Michigan Amber
Air 82	22	18	24	15	11
75	19	18	27	21	17
68	18	11	17	19	16
60	0	4	8	0	5
(Air 60 (Soil 46	0[a]	---	10[a]	9[a]	0[a]

[a] Two months after inoculation.

The data presented confirm previous observations in the field and in artificially inoculated outdoor plots. Clear mosaic symptoms have never been seen in the field in Kansas during the cool fall weather, even when transmission tests showed that many of the plants were carrying virus. Also, many plants from the field developed typical symptoms when moved into the higher temperatures of the greenhouse. Symptoms appeared in artificially infected outdoor plots only during the warm fall of 1950 (Figure 1), but assays of inoculated plants in the cooler fall seasons showed the virus to be present. Apparently decreasing air and soil temperatures lengthened the incubation period so that symptoms rarely appeared before spring. Those that appeared tended to be diffuse. Symptoms consistently appeared in the spring and became increasingly severe on new vegetative growth with rising spring temperatures.

SUMMARY

Five wheat varieties were tested to determine the effect of different controlled temperatures upon the incubation period and symptom severity of the yellow strain of wheat streak-mosaic virus. The incubation period increased with decreasing temperatures, the average being 5 days at an air temperature of 82° F., 7 days at 75°, 9 days at 68°, 15 days at 60°, and 23 days at 60° air temperature with a 46° soil temperature. During the early stages of the disease the most severe leaf symptoms appeared at 82° F. Symptoms later became more severe at lower temperatures. At 60° air temperature with a 46° soil temperature, symptoms

were typically diffuse and two varieties did not develop clear symptoms even though infective virus was obtained from the plants. Stunting from virus infection was slight to absent at the two lowest temperatures, but the reduction in plant height ranged from 16 to 20 percent at the three higher temperatures. These data show why symptoms are rarely seen on winter wheat in the field or in inoculated outdoor plots in the fall, even though infection has occurred. Mosaic symptoms appear in the spring and become increasingly severe with rising temperatures.

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KANSAS STATE COLLEGE, MANHATTAN

CHLOROTIC STREAK DISEASE OF PENNISETUM PURPUREUM

G. W. Bruehl

No host other than sugarcane (various forms of Saccharum spp.) has been recorded for the chlorotic streak virus. Martin[1] noted symptoms quite similar to those of this disease on sugarcane on Coix lachryma-jobi, but experimental evidence that they were incited by the virus affecting sugarcane has not been reported. It is therefore of interest to report observations and results indicating that this disease occurs on Pennisetum purpureum. In May 1952, near Central Coloso, Puerto Rico, typical symptoms of chlorotic streak disease were observed[2] in a plot of this grass in the midst of sugarcane fields on low level land. Later, in August, the author collected specimens of P. purpureum with similar symptoms on the Puerto Rico Agricultural Experiment Station, Rio Piedras. Cuttings for vegetative propagation were made from the lower portion of the stem to determine the possible virus-nature of the disease. One piece of each stem was planted untreated, and one treated in water

Table 1. Chlorotic streak observed[a] on shoots from untreated cuttings of Pennisetum purpureum.

Collection	Shoot Number	Leaf on which symptoms were observed														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1[b]	1	–	–	+	–	–	–	+	–	–	–	–	–	–	–	–
	2	–	–	–	–	–	–	–	–	+	+	–	–			
	3	–	–	+	–	–	–	–	–	–	–	–	–	–	–	
	4	–	–	–	+	–	+	+	+	–	–	–	–			
	5-10	Negative														
2	1-11	Negative														
3	1	–	+	–	+	–	+	–	–	–	–	–	–			
	2	–	–	–	+	+	+	–	–							
	3	–	–	–	+	+	–	–	–	–	–					
	4	–	–	+	–	+	–	–	–							
	5	–	–	+	–	–	–	–								
	6-25	Negative														
4	1	–	–	–	–	+	–	+	–	–	–	–	–	–	–	
	2	–	–	–	–	+	+	+	+	–	–	–	–			
	3	–	–	–	–	–	–	–	+	–	–	–	–	–	–	
	4	–	–	–	–	+	+	+	+	–	–	–	–	–		
	5	–	–	–	–	–	+	–	+	–	–	+	–	–	–	
	6	–	–	–	–	–	+	+	+	+	+	–	–	–		
	7-17	Negative														

[a] Symptom first seen at 27 days. The experiment was terminated at 2 months.

[b] Collections 1, 2, and 3 are Merker grass, a selection of P. purpureum, and 4 is Merkeron, a hybrid of two strains of P. purpureum. Mr. Gonzalez-Rios, Head, Plant Breeding Department, Puerto Rico Agricultural Experiment Station, observed the symptoms on Merkeron and offered helpful suggestions.

[1] Martin, J. P. 1938. Sugar Cane Diseases in Hawaii. 295 pp., illus. Honolulu.

[2] E. V. Abbott, G. W. Bruehl, and C. O. Grassl of the United States Department of Agriculture, and P. Gonzalez-Rios and Ferdinand Mendez-Roig of the University of Puerto Rico Agricultural Experiment Station, were present in the party that made the original observation.

at 52° C. for 20 minutes, which treatment eliminates the chlorotic streak virus from sugarcane cuttings. The hot water treatment did not injure the grass and no symptoms were observed on 65 shoots from treated pieces. Chlorotic streak appeared in 15 of 63 shoots from untreated seed pieces (Table 1[3]). This was evidence that the chlorotic streak of P. purpureum is incited by a virus. It is not known whether the chlorotic streak diseases of cultivated sugarcane and of P. purpureum involve the same virus.

JOINT CONTRIBUTION FROM THE DIVISION OF SUGAR PLANT INVESTIGATIONS, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING; AND THE PUERTO RICO AGRICULTURAL EXPERIMENT STATION.

[3]Similar erratic results were obtained in establishing the identity of chlorotic streak of sugarcane, by Jose Adsuar (Chlorotic streak disease of sugarcane in Puerto Rico, University of Puerto Rico Technical Paper No. 3, pp. 9-12, illus., 1946.)

SYMPTOMS OF HORMONE INJURY IN TOMATO, PEPPER, AND RUDBECKIA

P. A. Young[1]

Two fields of Rutgers tomatoes and a field of California Wonder bell pepper near Troup, Texas, were examined on June 6, 1952. The owner of the crop thought that drift of a chemical spray from the adjacent railroad right-of-way had damaged his plants. The plants within about 150 feet of the railroad showed symptoms that were typical of hormone injury. The severity of the symptoms decreased with increasing distance from the railroad.

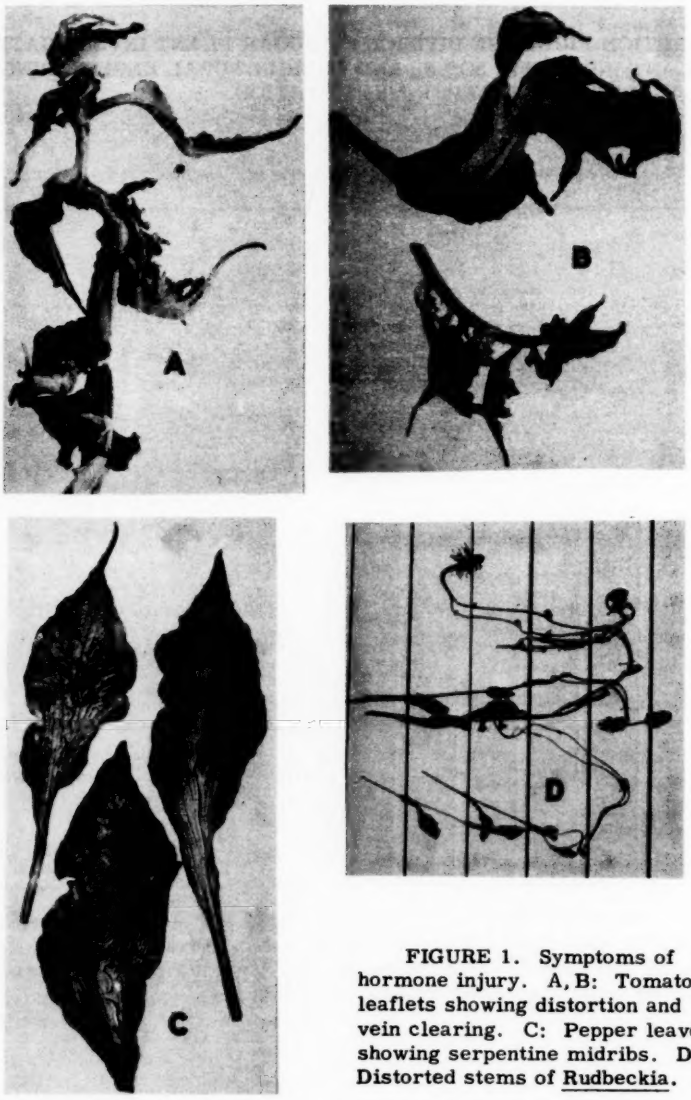

FIGURE 1. Symptoms of hormone injury. A, B: Tomato leaflets showing distortion and vein clearing. C: Pepper leaves showing serpentine midribs. D: Distorted stems of Rudbeckia.

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The tops of the affected tomato stems were abnormally curved; the young leaflets showed prominent distortion with abnormal parallel veins and nearly hyaline veins (Fig. 1, B). Many leaflets showed the "ramshorn" symptom of hyponasty (Fig. 1, A). Serpentine midribs and cleared nearly parallel veins characterized the pepper leaves with hormone injury (Fig. 1, C).

Within three feet of the railroad tracks, many small native plants were dead or badly injured, apparently by a chemical. Numerous plants of Rudbeckia maxima Nutt. four to six feet tall within 25 feet of the railroad tracks showed extreme curving and downward bending of the stems (Fig. 1, D).

It was learned that the railroad company had employed a commercial organization to spray the weeds along the railroad tracks about May 15, 1952. Evidently, wind blew some of the spray material or fumes onto the tomato and pepper plants in the adjacent fields. We were unable to learn the names of the chemicals that had been used in the spray. However, the symptoms were characteristic of those that may be caused by 2, 4-D, 2, 4, 5-T, or mixtures of these chemicals that are often used for controlling weeds. Organic phosphorus insecticides such as TEPP may induce hormone-like symptoms in sensitive species of plants such as tomatoes[2]. However, no evidence was found that such an insecticide had been used on this crop.

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[2]Hall, W. C. Morphological and physiological responses of carnation and tomato to organic phosphorus insecticides and inorganic soil phosphorus. Plant Physiol. 26:502-524. 1951; also Texas Agr. Exp. Sta. Progress Rept. 1421. 1951.

A PARASITIC NEMATODE FOUND ON DETERIORATING ROOTS OF SUGARCANE

Wray Birchfield

Roots from sugarcane plants, variety C. P. 44/101, obtained at Raceland, Louisiana, affected with the recently reported Sclerospora disease[1] (sp. undet.), were observed to be in a badly deteriorated condition. Examination of these roots showed a large population of nematodes identified as a species of Pratylenchus. The plants most severely stunted and which contained oospores of Sclerospora had practically no roots. The larger, better developed plants had more extensive root systems, but abnormally few small roots. These small roots were blunt, coarse, and showed characteristic brown lesions.

Roots were collected from plants selected at random over the field where the Sclerospora disease was present. Roots from the better root systems were kept separate from roots of the severely diseased plants. The roots were washed clean with tap water, cut into small pieces, and separated into lots of 50 grams each. Each lot was macerated in a Waring blendor for 20 seconds and then washed over a 300 mesh screen. The screen retained the nemas. After the pigments and soluble materials had been removed by a gentle flow of tap water, the residue was deposited in funnels as described by Baermann. The number of Pratylenchus in each sample of roots varied from 10 to 120. The lowest numbers were found in the most severely affected root systems, indicating that perhaps some of the nematodes may have left the roots prior to their death.

The relation, if any, of the nematodes to the Sclerospora disease has not been determined.

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[1] Abbott, E. V. 1952. Sclerospora disease of sugarcane identified in Louisiana. The Sugar Bul. 30: 390-391.

OBSERVATIONS ON THE ROOT LESION NEMATODE DISEASE OF NARCISSUS AND PROGRESS OF CONTROL

Harold J. Jensen

Premature dying of the roots and foliage of narcissus has been observed recently in the Pacific Northwest (2). This condition results in the formation of undersized bulbs and is especially important in Oregon where the disease is now widespread. The symptoms occur in certain areas of the plantings and reappear each time the fields are in production. All such occurrences investigated have been caused by a root-lesion nematode, Pratylenchus sp.

Knowledge of the host range among narcissus varieties has been greatly extended during the 1951-1952 season. Leucojum (Amaryllidaceae) was added as a new bulb host plant. Formerly the King Alfred trumpet variety was the only narcissus known to be susceptible. The following varieties of narcissus and a leucojum were found infected in commercial fields.

Narcissus[1]

Trumpet	Jonquilla Hybrid	Tazetta Hybrid
King Alfred	Lanarth	Geranium
Aerolite	Golden Perfection	Glorious
Dawson City		Klondyke
		L'Innocence
Poeticus	Leedsii	Incomparabilis
Actaea	Silver Star	Golden Pedestal
Glory of Lisse	Tunis	
Albus Plenus Odoratus		

Leucojum

Gravetye Manor

Current experimental evidence indicates that the planting stock is not responsible for the spread of the nematodes into new localities. The root-lesion nematode attacking narcissus has been recovered only from the root system. Scarcely any roots remain attached to the bulb of an infected plant at the end of the growing season. The few roots that remain attached to the bulb after curing, grading, and storage operations dry out, and there is little chance for survival of the nematodes since root-lesion nematodes are very susceptible to dessication (1).

Bulbs from 79 infected plants were planted in nematode-free soil to investigate the possibility of nematode carry-over. No root-lesion nematodes were recovered from their root systems. Another series of 52 infected plants were carefully dug to retain as much of the root system as possible. No viable root-lesion nematodes were found in the roots of these bulbs after a six-week drying period.

The first control measure tested was soil fumigation. DD (dichloropropene-dichloropropane) and EDB (ethylene dibromide) were applied in two field experiments. In one field experiment four small plots (12 feet by 24 feet) were treated[2] with a hand applicator (the Mac-Lean Fumigun) and sealed with a water-seal. The Warrenton Sandy Loam type soil with a moisture equivalent of 10.9 percent was relatively free from crop debris. The plots were planted with separate rows of small, average, and large King Alfred slabs. Table 1 summarizes the data from the small scale field experiment consisting of two control and four treated plots. Narcissus plants in the treated plots continued to grow four to six weeks after those of the non-treated plots had died. The increased yield of #1 bulbs in the treated areas compared with the non-treated areas was very pronounced. The higher dosages of these materials increased the yield of #1 bulbs four to five times.

Populations of root-lesion nematodes present in soil samples from treated plots were very erratic during the growing season and no consistent trend was observed. The popula-

[1]The host plants are listed in varietal groups corresponding to the "divisions" of the classification used by the Royal Horticultural Society.

[2]An injection depth and spacing of six inches was used.

Table 1. The effect of DD and EDB on the percentage of #1 narcissus bulbs harvested from miscellaneous planting stock.

Treatment	Bulbs produced			Approximate cost of material per acre ($)
	Total number	#1 Bulbs Total number	#1 Bulbs Percent	
DD 25 gal. per acre	59	34	57.6	37.50
DD 50 gal. per acre	51	36	70.6	75.00
Control no treatment	54	8	14.8	-----
EDB 5 gal. W-85 per acre (not-diluted)	55	15	27.3	33.60
EDB 10 gal. W-85 per acre (not-diluted)	44	26	59.1	67.20
Control no treatment	50	5	10.0	-----

tions were considerably greater in the controls than in the treated areas. No comparison was made of the number of nematodes in individual root systems of plants for each plot, since the plants in the control areas had lost nearly all of their roots early in the season. Although some lesions containing nematodes were present in the roots of plants growing in the treated areas, no extensive damage such as the premature loss of roots occurred.

Similar treatments were applied with a power-drawn chisel applicator in another experiment consisting of larger plots. The effects of the treatments were irregular in the treated areas. The power-drawn equipment failed to duplicate the favorable results obtained with the hand applicator. Although results from the small plots are very encouraging, no satisfactory recommendations for control can be made at this date.

The major effort in soil fumigation research has been in the development of new materials, with little or no attention given to the improvement of application methods or application machinery. Further investigations in Oregon will stress improvements in methods of application of fumigants to the soil. The need for further investigations is emphasized by the fact that Oregon growers fumigated nearly 90 acres for the control of the root-lesion nematode disease of narcissus in 1952, although adequate methods for the application of fumigants are not available.

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CHARCOAL ROT (CAUSED BY SCLEROTIUM BATATICOLA TAUB.) ON GUAYULE IN SOUTHWEST TEXAS IN 1951-1952

Don C. Norton and F. A. Frank[1]

Sclerotium bataticola Taub. is a common soil-borne fungus which infects many wild and cultivated plants in Texas during hot, dry weather. It has been isolated from diseased guayule tissues on previous occasions (1, 2, 3, 4). However, its pathogenicity on this crop was questioned until 1944, when Presley (3) reported on outbreak of the disease causing appreciable loss on two-year-old plants.

In southwest Texas, guayule plants are started from seed in surface-irrigated nurseries. They are kept lush for about six to eight months, at which time they are hardened-off and transplanted to dryland plots. The plants are harvested for rubber when three to five years old.

During the summer and early fall of 1951, the Winter Garden area of southwest Texas was hot and dry. Although the mean temperatures for the summers of 1950 and 1951 were comparable, there was a total of about 15 inches rainfall during the period June 1 through September 30 in 1950, as compared with about 2.5 inches for the same period in 1951. The severe drought continued through the early fall of 1952.

During 1951, in the nurseries, charcoal rot was first found in June on plants eight weeks old. The disease appeared only in fields where irrigation was inadequate. The tops of the plants wilted suddenly, with no recovery upon watering. When young roots were cut lengthwise, blackened woody inner tissues were revealed. Isolations from the margins of diseased and healthy tissues consistently yielded S. bataticola. The over-all damage in nurseries from this disease was estimated to be about 5 percent, although losses up to 50 percent were observed in some local areas. With increased irrigation, further loss from charcoal rot amounted to only a trace, despite the fact that the mean maximum air temperatures were 102.1° in August and 94.8° F. in September. No large nursery plantings were made in 1952.

There is some indication that nursery plants which are gradually hardened-off prior to transplanting are more resistant to this disease than plants growing under conditions where lush growth is suddenly terminated by hot, dry weather.

In a ten-acre dryland planting of guayule near Dilley, in Frio County, charcoal rot appeared in September 1950, after a comparatively short dry spell. This outbreak caused losses of 5 and 10 percent on plants approximately one and one-half years old. During most of the summer of 1951, additional loss from the disease in this field amounted to about the same. However, in the early part of September, there was a sudden increase in damage which reached 70 percent in some parts of the field.

It seems possible that the condition and drainage of the soil have some influence on the disease incidence. Part of the field, where most of these observations were made, slopes gently

Table 1. Percentage loss from charcoal rot, in relation to the spacing of guayule shrubs planted in February 1949, in a field near Dilley, Texas, on four dates.

Spacings (inches)	Percentage loss			
	Sept. 27, 1950	Dec. 1, 1950	June 20, 1951	Oct. 30, 1951
6	3.8	3.5	3.1	68.8
12	5.7	5.3	4.4	60.9
18	5.4	5.0	4.6	60.9
24	7.3	6.9	6.8	63.5

[1]Respectively, assistant professor, Department of Plant Physiology and Pathology, Texas Agricultural Experiment Station, College Station, Texas, and formerly agent (agronomist), Division of Rubber Plant Investigations, U. S. Department of Agriculture, Crystal City, Texas.

Table 2. Percentage of plants that had died from charcoal rot in cultivation plots by dates indicated.

Years when cultivated	Percentage dead plants: March 10, 1952	Percentage dead plants: October 24, 1952
1949	70.25	86.4
1949, 1950	34.17	58.0
1949, 1950, 1951	40.84	----
1949, 1950, 1951, 1952	-----	59.1

Table 3. Percentage of dead plants from charcoal rot on selected varieties, at dates shown.

Variety	Percentage dead plants: June 20, 1951	Percentage dead plants: Oct. 30, 1951
109	3.3	51.9
130	5.6	64.7
593	3.8	63.9
4265	1.0	20.2

from west to east, while the other part is nearly level with consequently poorer drainage. The plants, which had been grown in the Salinas, California, nursery, were set in February 1949. That year was unusually wet for this area of Texas, and the plants, especially those on the level land, grew rapidly and lushly. When high temperatures and drought occurred in 1950 and 1951, losses from charcoal rot were much higher on the flat and poorly drained part of the field.

In several other plots throughout the Winter Garden area of Texas, where charcoal rot was comparatively light during the past years, damage was more severe on the wider than in the narrower spacings. An example of one such case is presented in Table 1. Presley (3) earlier noted a similar trend in 10- , 20- and 40-inch spacings where the maximum loss was 10.3 percent. Most observations in the present study were made on the highly susceptible but hitherto widely cultivated variety 593. However, from a few results with variety 4265, the trend appears to be the same.

Tingey (5) found that soil around closely-spaced guayule plants is drier than soil around widely-spaced plants. It is frequently observed that guayule plants grow more vigorously in wide spacings than in narrower spacings. The effects of spacing on host-parasite relationships have not been investigated. However, in drier soils it is possible that there is a greater thickening of the outer layers of the root, which could retard penetration of the fungus. Also, greater storage of resin or other substances, or differences in internal water relations in the root, conceivably could be responsible for the greater resistance in the slower-growing plants.

In a cultivation trial over a four-year period, charcoal rot was much more severe in the plots that were cultivated only in the first year, as compared with those cultivated from two to four years (Table 2).

Weeds became well established in the plots cultivated only in 1949. As noted earlier, the vigor of growth is greatly influenced by the soil water conditions. One possible explanation for the higher incidence of charcoal rot in the 1949 plots is that following an initial lush growth, the abundance of weeds along with the absence of cultivation during the three succeeding years, considerably reduced the soil moisture below that of the other plots.

Some varieties of guayule are more resistant to the disease than others. Even in severe outbreaks, variety 4265 appears to be about three times as resistant as the commonly cultivated variety 593 (Table 3).

Charcoal rot can readily be controlled by irrigation, in spite of high temperatures which might prevail. However, owing to the type of growth favorable for a high yield of rubber, lushness is not always desired. For this reason, together with the high cost of irrigation, guayule is transplanted to dry land.

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BRIEF NOTES ON PLANT DISEASES

OAK WILT IN SEVEN KANSAS COUNTIES

By O. H. Elmer, I. J. Shields and C. T. Rogerson

The oak wilt disease, which previously has been reported from two counties in Kansas (PDR 35: 119, and 36: 68), is now known to occur in seven counties in the northeastern portion of this State.

An aerial survey of the 19 counties constituting the eastern two tiers of Kansas counties was made in July 1952 by cooperative effort of the Kansas Agricultural Experiment Station and the Kansas State Entomological Commission. In this survey 129 locations in which the presence of oak wilt was suspected were recorded, of which 90 later were visited by ground crews. Samples from suspected trees for attempts to isolate the oak wilt fungus were obtained from 69 locations, of which 31 yielded positive cultures of Endoconidiophora fagacearum Bretz. The isolation work was done in the plant pathology laboratories of Kansas State College and the University of Kansas. Further investigations in both of these laboratories have resulted in ascospore production from paired cultures of a number of the isolates that were obtained.

Kansas counties in which the presence of oak wilt infection was proved in 1952 include Doniphan, Jefferson, Leavenworth, Johnson, Miami, and Douglas. The presence of oak wilt had previously been reported from Douglas and Wyandotte Counties and new locations were found in Douglas County in 1952. Some of the locations in which infected trees were found consisted of rather extensive ground areas, in some of which 25 or more oak trees had died. The oak wilt disease was apparently present in Kansas for a considerable number of years prior to its discovery in 1950, as is indicated from decaying stump remnants of oak trees within these areas.

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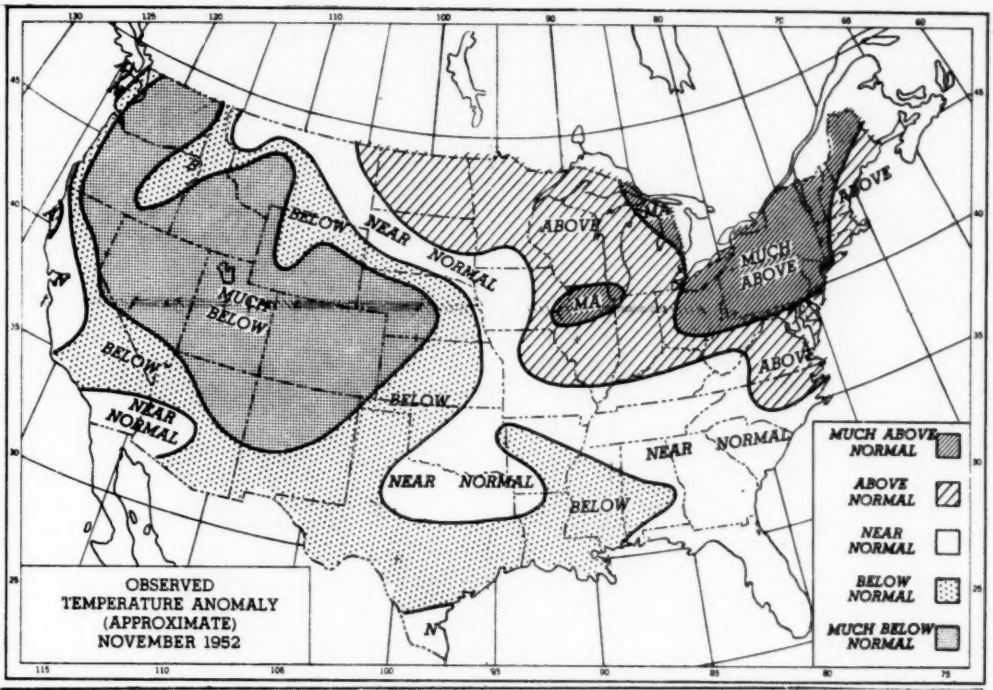

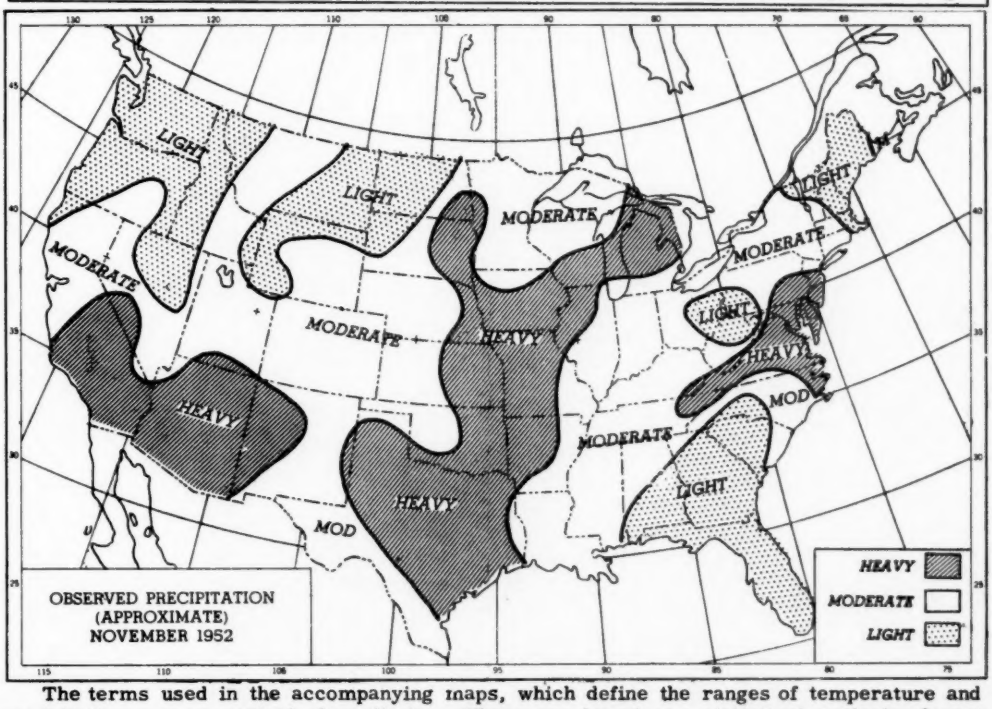

The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.